Virtual and Augmented Reality-Based Environmental Pollution Analysis in Smart City Using Wireless Sensor Network Enabled Hypertext System

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Abstract. The smart city has emerged in the recent decade, and it encompasses a wide range of modern city life. Environmental pollution has become a major urban development problem as population density rises. Virtual reality (VR) and augmented reality (AR) is an interactive experience of a real-world setting where computer-generated perceptual information, sometimes spanning several sensory modalities, enhances the real-world items that live in the actual world in a hypertext system. The state has devised a plan for building smart cities to address the myriad issues resulting from increased urbanization. It is crucial to the smart city development process and plays a major role in environmental protection and monitoring the atmospheric environment. The conventional automated atmospheric monitoring station is not widely accepted because of its complex design, high cost, and challenging operating conditions. Conventional automated atmospheric monitoring stations are not widely adopted because of their complex design, expensive cost, and hardworking circumstances. Environmental pollution analysis of smart cities based on wireless sensor networks (EDMS-WSN) has been proposed as an alternative to the current system due to its scalability and intelligence. Environmental variables such as pollution can be better tracked with the help of IoT-enabled sensors connected to wireless sensor networks (WSNs). The system is tested to ensure the consistency of information acquired by the sensing element and the network's coverage. The results show that the suggested system is a visually effective environmental monitoring management system. The numerical results show that the suggested method has an environmental sustainability ratio of 92.11%, an environmental monitoring ratio of 89.9%, a CO_2 emission level of 93.8%, a temperature rate of 93.32%, a utilization cost of 96.8%, a precision ratio of 92.11%, and productivity ratio of 92.11%, overall performance in interactive device 93.88% than other existing methods.

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1 INTRODUCTION OF ENVIRONMENTAL POLLUTION ANALYSIS OF SMART CITY

It has long been accepted that pollution or change occurs when a build-up of environmental pollutants causes harm, injury, and suffering to physical processes or living organisms. Hazardous gases, contaminated water, and other agricultural pollutants injure crops as part of environmental pollution [2]. This study aims to reduce pollution, leading to a wide range of health problems in humans. Contaminants such as various hazardous gases, chemical substances, and dust particles are the primary cause of air pollution, harming human health and negatively impacting the ecosystem [29]. Volatile organic compounds (VOCs) and automotive and industrial emissions are the most common polluting sources. Clean air is an essential requirement for optimal health because environmental degradation is a severe threat to human health. As a result, they concentrated on environmental pollution monitoring in cities and industrial areas utilizing Wireless Sensor Networks installed on public vehicles [32]. Monitoring air quality is not about gathering data; scientists, policymakers, and planners were provided with the knowledge to make well-informed environmental management and improvement decisions. An essential part of this process is monitoring to gather the data and information needed to formulate policies and strategies, identify progress toward goals, and formulate enforcement methods. Greenhouse gas emissions may be reduced via the usage of AR and VR. In 2019, about half of all Americans went to the movies. Environmental contamination is exacerbated by the large number of journeys taken for amusement. Through computer technology, a virtual world may be created that can be explored in all directions at once, Virtual Reality. Virtual reality immerses the user in a virtual world, unlike conventional interfaces.

Air pollution's negative impact on human health is a significant issue, particularly in nations where the oil and gas industries are widespread [33]. There is a lot of effort to improve the air quality both inside and outside the home. The EPA lists ground-level ozone (O3), carbon monoxide (CO), and hydrogen sulfide (H2S) as three of the most hazardous air pollutants [24]. This type of information is frequently provided within the time range specified by the standard. O3 and H2S, on the other hand, are reported based on an 8-hour average, not a 1-hour average. Traditionally, large air quality monitoring stations have been employed to measure the quantities of various gases [1]. Each reference analyzer at these facilities measures a different gas. Several technologies operate together to prevent a wide range of gaseous and solid pollutants from entering the atmosphere largely via industrial smokestack emissions. Real-time air pollution updates are provided via sensors, allowing for precise monitoring. AI-assisted monitoring technologies examine large data streams and allow for improved analysis utilizing machine learning of weather and commuter traffic information to help identify bad air quality regions. The health and well-being of both humans and the environment reduce air pollution. The respiratory and cardiovascular systems may be negatively affected by poor air quality. Smoke and haze from pollution may limit vision and harm plants and structures.

The exceptional accuracy of these analyzers necessitates frequent calibration and maintenance, a power outlet for the air conditioning they use. As a result, they cannot make meaningful use of it [22]. Recent advancements in micro-electromechanical (MEMS) technology allow for more affordable, smaller, and mobile sensor stations. There are a variety of indoor and outdoor locations where these stations can be found. Research into wireless sensor networks (WSNs) is on the rise due to their wide range of applications, including military, transportation, and environmental monitoring [13]. Water quality, air pollution, and agriculture are monitored with WSNs, which keep tabs on traffic density and road conditions. There are several sensors in a wireless sensor network (WSN). Power, processing, sensing, and communication units are the four main components of a sensor station.

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Consequently, low-power sensor stations powered by batteries should be possible [18]. Some sensors feature batteries recharged using solar power, operating for extended periods. Before delivering data from sensors to the network, the processing unit collects and processes the data. An air quality monitoring sensor network has been proposed [16]. According to the researchers, multi-input, single-output artificial neural networks overcame sensor temperature and relative humidity (ANNs). Researchers have developed air pollution concentrations [11]. An air pollution monitoring wireless sensor network auto-calibration approach is proposed. A high degree of precision is accomplished with this strategy, as demonstrated by the simulation results [4]. A hypertext environment to study the impact on incidental learning of fact-retrieval search (browsing vs. index-using). Browsers should have more opportunities from a cognitive standpoint to draw connections between the numerous articles and have a deeper comprehension of the topic, as was expected that browsing would lead to greater unintentional learning.

There have been numerous improvements made to WSNs during this period, ranging from the design to the functioning of the network. The resilience and energy efficiency of sensor networks is a must. WSNs in the network need to be redesigned or upgraded to extend their life span, regardless of implementation [9]. They used wireless sensor networks to keep traffic congestion, disaster warnings, and even our homes and health care facilities. In a wireless sensor network, sink nodes, sensors, and communication links are put on the ground, in a structure, and in a vehicle, among many other places [10]. A sensor node comprises a transmitter, data processing components, receivers, and an energy source, all of which are separate. When a sensor node detects something, it must transmit that information to another sensor node or a sink node [7]. For example, sensing components of wireless sensor networks measure various environmental parameters, including gas concentrations, smoke concentrations, and dust particles. Pollution is the result of that. A computer system carries out the data collection procedure [26].

Sensor's data-gathering technologies and society have become increasingly dependent on wireless sensor networks (WSNs) during the past few years. People are increasingly concerned about environmental issues such as climate change, agricultural intensification, and air pollution [20]. Area networks, Wireless, and ZigBee networks are used by autonomous devices to monitor ambient and sensor data. Pollution is defined as any energy or substance that adversely affects the health, aquatic life, or the environment whole. Coal combustion in homes during the 18th and 19th centuries resulted in cause traffic delays, suffocation to humans, dizziness, migraines, and other health issues [3]. As the population grows, so does the degree of pollution. Acid rain and its corrosive effects are caused by excessive sulphur dioxide and nitrogen oxide emissions mixed with water molecules. Acid rain has a detrimental effect on paint peeling and steel corrosion, such as bridges. Stone statues, forests, freshwater, and soil are all at risk [12]. Causing structural damage and having negative effects on people's health Animals found in or near water Cities' pollution is not a new issue. Coal was the primary fuel source during the early years of the Industrial Revolution. High levels of pollution are caused by coal usage, both in industrial and residential settings [17].

Pollution develops into smog when the weather is overcast. A rise in death rates caused by smog causes traffic to be disrupted, causing cities to grind to a standstill. Smoke pollution was reduced under the Public Health Act, and higher industrial controls helped minimize smog pollution in the twentieth century [25]. The Smoke Abatement Act is a federal law enacted to limit smoke emissions. Air, land, or water pollution negatively impacts human health or negatively affects the quality of life for other living things by changing their physical, chemical, or biological characteristics [19]. There has been an uptick in awareness of and deployment of WSN technology in recent times. The world's population is projected to be 70 percent concentrated in cities and their environs due to rapid urbanization. Because of this, improved management of our cities' economic, social, and environmental is required. Sensors and pollution monitoring devices, including devices that collect data from the sensors and aspects of the physical world (sensing), are predicted to revolutionize city management through the growing (WSN) employing internet backbone technologies to help with information. Pollution levels are determined by the number of dust particles in the air, moisture, light

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levels, and ambient noise [8]. Our troubles are alleviated by the rapid advancement of information technology and human needs for contemporary technology. Automation, accuracy, and accessibility from any location were all critical requirements of environmental friendliness [23]. Wireless sensor networks have all of these characteristics (WSN). This paper's most important contribution is,

- The typical autonomous atmospheric monitoring station has difficulty finding widespread acceptance because of its complicated design, high cost, and tough working circumstances.
- To overcome the current system's deficiencies in terms of scalability and intelligence, an environmental detection and monitoring system (EDMS-WSN) was proposed.
- The system is evaluated to make certain that the data collected by the sensor and the network is consistent.

An upcoming section is organized: Section 2 discusses similar work and its corresponding discussion. Wireless sensor networks, named EDMS-WSN, are discussed in Section 3 for environmental detection and monitoring. A comparison of findings and a forum in Section 4 with an existing technique is made in Section 5, which finishes the work and considers the scope of further research.

2 LITERATURE REVIEW

This section goes through how to help them locate relevant topics, approaches, and future research. This section offers a review of scholarly articles on a specific subject. When doing an experimental literature review, researchers look at all the available material on a certain issue and identify gaps that need to be filled. There are two broad categories of condition monitoring methodologies: model-based and data-based. The advantages and disadvantages of each group are unique. It is a mathematical representation of system behavior used in model-based techniques.

[15] examined the monitoring systems and big data systems in more detail in the following article. Using a combination of sensor networks and big data analytics (SN-BDA-SMS), a single monitoring system was developed to keep track of the entire process of storing and distributing goods. Logistical monitoring is traditionally done by hand, which is both inefficient and time-consuming. It also cannot fulfill the current size and intelligence needs of today's logistics sector. When tested, it was shown to have deployment reference importance and practical application value. This means it has the potential to enhance logistics management's informatization and intelligence level.

[28] presented a wide range of blockchain applications offer answers to challenges in risk management and financial services, cryptocurrencies, and the Internet of Things (IoT). This study goes into great detail on the various variables that will help bring these two technologies together. Blockchain-AI-based intelligent transport systems (BCAI-ITS) benefited from a wide range of security enhancements, which they explained in detail. New security recommendations and instructions for a healthy smart city ecosystem are among the challenges that remain unresolved and the focus of our future study.

[21] improved the overall processing speed of the mobile edge computing system, the available resources around the mobile edge server are combined. It has been recommended that the MEC be used with alternating direction multipliers (MEC- ADMM). Enormous processing load is imposed by the utilisation of a single mobile edge server. Our goal in this study is to provide a collaborative technique for doing computations as the quantity of data grows. It is then checked through experimentation whether or not the distributed task scheduling algorithm and the distributed device coordination method work.

[31] discussed that cities could be intellectualized using cloud computing platforms. With the blind building projects and unsatisfactory results during the construction of smart cities, they carry

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out theoretical research on a smart city testing system using cloud computing platform design (SCTS-CCPD), the indexes included within smart cities and their relationships. They further propose a method for smart city evaluation. They suggested an application-focused cloud computing platform design that enhanced evaluation findings and increased the smart city's potential as the last step.

[27] proposed the hybrid smart city cyber security architecture (HSCCA) to create safe data, and this technique assesses dangers. They advocated a layered approach to data storage and service delivery for the HSCCA, which explains multiple participants and provides end-user service quality. For smart cities, Cyber Security (CS) was an important consideration. In the end, evaluating some of the most significant security measures for smart cities put forth by HSCCA for our research. This research suggested a safety arrangement tailored to the specific scenario for typical cyber-physical systems.

[5] discussed that smart city construction was examined to see how it affects ecological environment quality (EEQ). Many local governments are implementing new strategies to address urban challenges, such as creating "smart cities," which can increase science and technology and resource efficiency, which will help reduce pollution. As a result, changes in the city's smartness level can significantly impact the surrounding environment. For conceptual and empirical purposes, they modify a classic land allocation model to demonstrate how local officials' obligations to protect the ecological environment and stimulate economic development can lead to the long-term spatial development of smart cities, resulting in an improvement in EEQ [34].

[6] introduced that cities face is a few of the issues that traffic jams, air pollution, energy usage, and urban sprawl. These issues have prompted the development of a smart city idea. There is a need for a thorough decision-making framework for present smart city programs. Nevertheless, Repeated surveys of decision-makers were conducted in this research to get various viewpoints. According to the findings of these studies, IAA is a valuable strategy for researchers studying smart city dimensions, ideas, and decision-making procedures in theory. Smart city project implementers may benefit from this information.

[14] explained as the Internet of Things (IoT) and cloud computing spread around the globe, people from all walks of life have begun to move toward a more "intelligent" contemporary civilization. Smart cities are progressively adopting these technologies. Since antiquity, the old urban system passed down from generation to generation has operated very inefficiently and laboriously. Information has not been exchanged and networked amongst systems properly. The experiments found that the system can tackle the problem of information islands and suit the demands of smart cities by sharing, exchanging, and fusing data from multiple sensors.

[30] proposed the article investigates whether or not inhabitants in a smart city are ready for crowdsourcing services to be implemented. Methodological approaches are needed to identify those Internet of things and mobile technology-based crowdsourcing services that stimulate public engagement. Public transportation and environmental conservation services (crowdfunding for solar energy development and environmental preservation) seem to be well-received by residents, according to the findings of the survey (crowd voting and crowd wisdom services that can improve the state of the public transport). Using the suggested methodological approach and the acquired findings, towns and governments in Serbia and elsewhere might begin implementing smart city initiatives.

According to the investigation, the existing BCAI-ITS, MEC- ADMM, SCTS-CCPD, and HSCCA strategies for environmental protection and control are flawed. To address the current system's shortcomings in terms of scalability and intelligence, planned and implemented a wireless sensor network (EDMS-WSN). The paper examined a unique training model technique to overcome the abovementioned concerns.

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3 PROPOSED METHOD

This section discusses the wireless sensor network-based detection and monitoring system (EDMS-WSN). The research topics of the chosen articles were examined, and reviewers aggregated and summarised similar concerns instead of writing them all individually. The structure and organization of the technique structure below provide an overview of their general characteristics.

3.1 Wireless Sensor Network-Based Detection and Monitoring System (EDMS-WSN)

Wireless Sensor networks are frequently used in environmental monitoring. Sensor networks have various kinds of characteristics over traditional approaches for environmental monitoring. Human impact on the environment should be minimized by minimizing sensor device volume and deployment time so that sensor networks can be installed in places with problems wiring and electrical power, areas that are accessible to employees, and some transitory situations. Second, the network has many sensor nodes and transmits data quickly. Each node collects and transmits detailed information about its immediate surroundings throughout the network. Since the sensor network can collect a great volume of information while being highly precise, Nodes should communicate wirelessly, have sufficient computational power, and do more complex monitoring in response to changes in the physical environment. Nodes should be able to work together to perform collaborative monitoring. Lengthening the lifespan of sensor networks is made possible by utilizing smaller transceiver modules and transceiver techniques, increasing the number of battery packs and improving battery capacity. Cutting-edge technology and components are needed to complete our capabilities. In the design and planning of a system, technologically advanced, material and equipment and system upkeep are critical. Function design should consider the collecting and monitoring of signals and the management and analysis of information. It ought to be durable and simple to grow on. The wireless sensor network supports Real-time environmental monitoring and management.

Whether or not a system function is directly related to online equipment diagnostics and mechanism measuring performance. Therefore, the system must function consistently, and consistency should be prioritized during the design and planning stages. In addition, the system's scale must be easy to extend in light of the system's huge scale and variety of roles in the future.

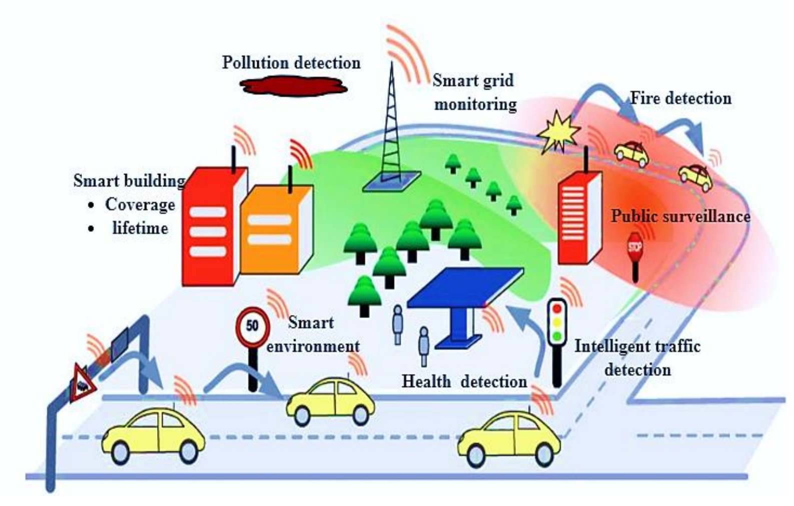

Figure 1: Environmental pollution analysis of smart city.

As illustrated in Figure 1, smart city surveillance systems have substantially improved our quality of life by increasing our sense of security and comfort. However, these systems have created new and

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difficult research problems for effective sensing and monitoring. Sensor nodes have limited communication and compute capabilities due to their small size. For example, if they are battery-powered, their operations must be energy-constrained, and they have a small amount of processing and storage power. The number of sensors accessible is limited, particularly when providing high-resolution data with a high degree of accuracy or specific uses.

As a result, to meet monitoring needs while keeping costs low, we need to think about how to implement WSNs for the city of the future sense while considering the sorts of nodes to be used, where to place them, and how to cover the required area adequately. A large amount of research has been done to address these difficulties. Smart city surveillance devices have yet to be designed or maintained following clear guidelines. A lack of standard operating procedures will encourage ad hoc solutions, which are more difficult to replicate and hinder the adoption of effective sensing systems. If we don't set such norms, they risk seriously impeding a healthier, prosperous, and productive urban lifestyle. Both node deployment and sensor management are critical concerns in smart city design and maintenance. These issues have been addressed in various contexts, but a unified strategy is still lacking. As a result, we've conducted a literature review to find out what's known about these issues, how they are applied to smart city monitoring, and what can be done to enhance things further.

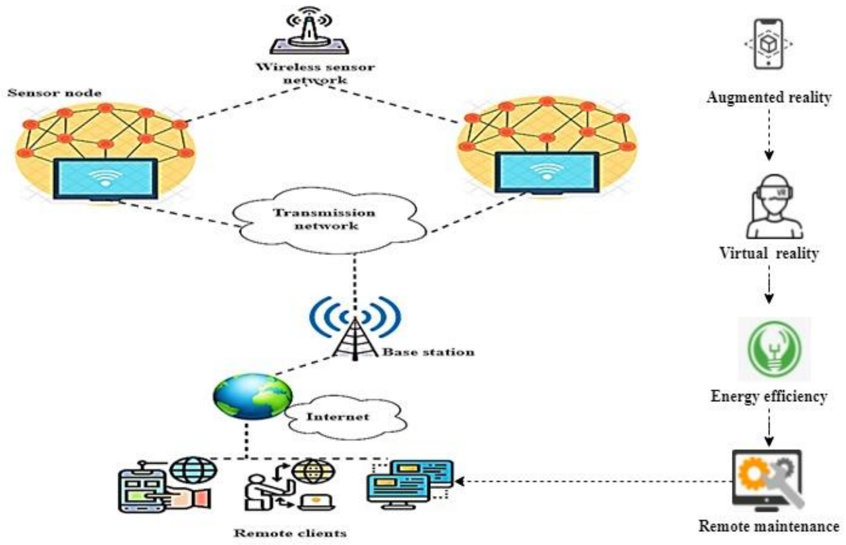

Figure 2: General structure of the wireless sensor network environmental monitoring system.

The sensor network environment monitoring system is shown in Figure 2. Eventually, the sensor node links to the transmission network, connecting to the base station, and finally, the internet. Multiple non-adjacent monitoring zones are densely packed with sensors to ensure data accuracy and system longevity. An autonomous sensor node, autonomous sensor node connects with other nodes and transfers data to other nodes. The gateway node sends sensor data to a remote base station. Local transmission systems connect all sensor network gateway nodes, which aggregate data from all access points. The base station has an internet-connected processor and a wireless node for data transfer and network status monitoring. Digital visual components, music, or other sensory cues are used to improve the actual environment in augmented reality via technology. In VR, the viewer enters a computer-generated world where the scenery and objects seem genuine, giving the impression that they are there. Energy efficiency is the practice of utilizing less amount of energy to accomplish the same activity. The reduction of greenhouse gas emissions is only one of the many advantages of energy efficiency. Computer systems may be monitored and operated from a distant

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location as part of remote maintenance. This is accomplished via the use of remote-access software installed on local computers.

Data storage and processing are among its responsibilities. A data server might be a network device or a computer linked to the web. The data server and the base station can be accessed from any internet-connected device. The autonomous action of each node forms a multi-hop network of sensor nodes. The sensor network's edge nodes must communicate with the gateway via other nodes. A gateway for each sensor region collects data from the sensor nodes in that area. Communication bandwidth and reliability among nodes in the network and base stations are ensured by a high-capacity transmission network that contains numerous wireless transmission nodes with high computation and storage density and UPS power. The base station receives all transmission grid data and transfers it to the internet, saved in a database. Data generated by a sensor network can be sent to a database over the internet, providing remote data services based on real application requirements for data reliability.

3.2 Wireless Sensors Nodes' Architecture

A broad measurement range, a lengthy period, and a complicated monitoring scenario characterize atmospheric environmental monitoring. This necessitates the arrangement of a high number of communication nodes. The node in this type of sensor network serves as both a routing node and a sender and receiver of data. As the sensor node collects, processes, and sends data, it should store, categorize, and aggregate it. It works in conjunction with other nodes for collecting sensor data. The gateway node is primarily used to change the operating system's network capacity protocol to merge many independent networks. A gateway node connects two or more networks. The wireless sensor network node is the most complex one. Connecting devices with varying network communication protocols is one of its primary responsibilities. LAN and WAN network connections can be made through the gateway, which is capable of doing so. Wireless sensor networks rely on this device for protocol conversion.

An air quality monitoring infrastructure is depicted in Figure 3 as part of this system, and four MG monitoring stations have been installed in Education City. The Smart City control points have been deployed and are functioning properly. This is a test run, and more sites will be added soon. This study's sensors have been operating reliably at temperatures up to 50°C and frequent weather damage for four months before writing. An end-to-end solution consists of the smart city monitoring sites, the server's back end, and the platform. The smart city control points are linked to the backend server via an M2M connection. Detailed information about each of these components can be found in the following sections. In addition, the wireless communication unit can provide an ad-hoc communication method for sensing stations that are part of the WSN. Compared to a single long-range hop, communication across short distances using multiple hops is more resource-efficient (BS). We've talked about using an intelligent sensor network to keep tabs on air quality in the past. According to the authors, an artificial neural network (ANN) can be utilized to tackle the inherent difficulties of the sensors used, such as the dependence on both environmental temperature and relative humidity. Any wireless communication or computing device, such as a mobile phone or a netbook computer, is included in the context of an interactive device. Hypertext is a text linking system that enables numerous users to participate. The use of hyperlinks in a hypertext document allows any text within the document or in a different document to be connected to information about a certain word or phrase. Ecology education and ecological awareness are often used interchangeably. To be environmentally conscious is to understand how our activities affect the environment and the ecosystems that support it. The actual components of a computer are known as hardware. Any portion of the computer that we can physically touch is referred to as "Computer Hardware." Computers run on software, a collection of instructions, data, or programs. A computer's software, or "software," refers to the computer's underlying operating system.

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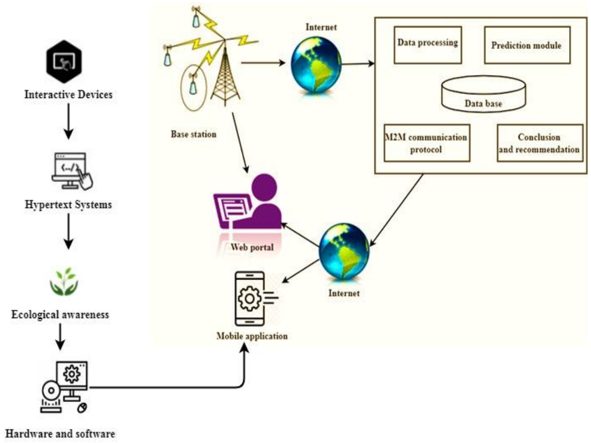

Figure 3: Design structure to monitor pollution levels.

An Analysis of WSN Figure 4 depicts a Wireless Ad-Hoc Network (WSN), an ad-hoc network with many nodes. These nodes are placed in various locations, some of which are not predefined at the time of deployment. If interested in detecting specific events, scatter them randomly across a geographical region designated as a "well field. Each sensor node in this form of the network gathers and sends environmental data on its own in a self-contained manner. A node designated as a drain is used as a collection point for all the data that has been sensed. The network user can connect to the latter. There will be careful consideration of the prospects and challenges for advancing water evaporation-induced electrical technology at fundamental and industrial scales. Furthermore, this research proposes a fresh approach to the future development and application of light-to-steam-induced electrical technology. An evaporation system powered by solar energy connects to other devices, such as a photothermal storage device, photovoltaic device, or saltwater power extraction device, to provide power to those other devices. In such devices, electricity is generated by using heat-produced water evaporation. The tandem system's power generation efficiency is lowered if there is too much space between the two devices. As a result, hybrid devices have a higher potential for energy conversion efficiency than tandem devices. Solar-driven water evaporation photo-absorbers connected directly on top of other photodynamic power devices are included in the hybrid system. Lastly, water evaporation can be used to generate electricity on its own.

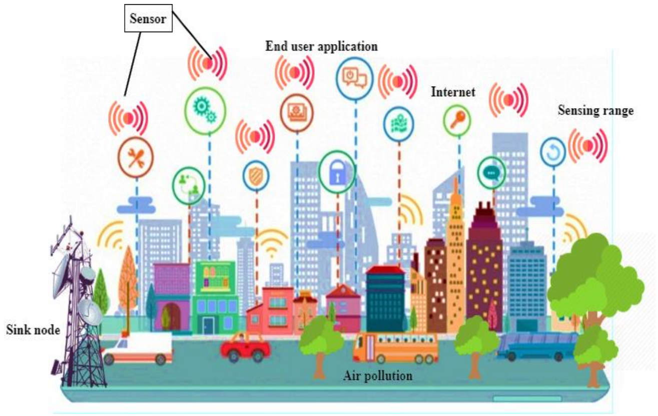

Figure 4: Schematic diagram of a wireless ad-hoc network (WSN).

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3.3 For the Assessment Phase, EDMS-WSN Uses an Algorithm.

They used real-world pollution propagation models to develop an accurate air pollution model. Many models have been designed and tested to study the dispersal of pollutants in the atmosphere. These models have a wide range of uses, including weather forecasting, assessing contamination, and poisoning detection. For the most part, theories of atmospheric dispersion are based on fluid mechanics. The Gaussian dispersion model, in particular, is the emphasis of this work without sacrificing generality. To find out how much pollutant is present, use the following equation.

$$D(a,b,c) = \frac{P}{2\pi\mu\sigma_b\sigma_c} \frac{e^{-b^2}}{2\sigma_b} \left(\frac{e(-(c-H)^2)}{2\sigma_b} + \frac{e(-(c+H)^2)}{2\sigma_b}\right) \quad (1)$$

Equation 1 shows the D is pollutant concentration (g/m3), σ_b is horizontal dispersion coefficient, σ_c is vertical dispersion coefficient, P is the rate of emission from the source, μ is the wind speed, H is infra-red emission height.

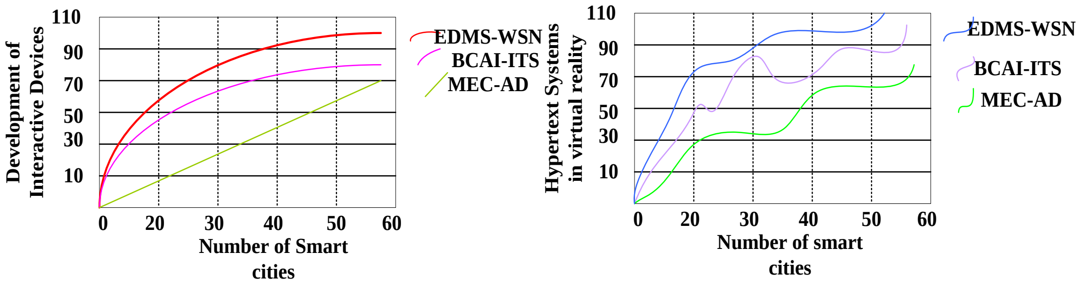

Figure 5: (a) Smart cities in the development of interactive device (b) hypertext device in virtual reality.

The total height of the polluting sources Δh and plume h's rise represent the pollutant effective release height H. In most cases, Δh parameter is calculated using Briggs formulas. For brevity, they simply look at the instance where the pollutant T_s is hotter than the air T_x. The following is the formula for calculating Δh:

$$\Delta h = 1{,}6.F^{\frac{1}{3}}.\frac{a^{\frac{2}{3}}}{\mu} * (r_{-1}/u_{-x}) \quad (2)$$

$$F = \frac{g}{\pi}.W - \sqrt[2]{\mathbf{a^2} - p^2} * \left(\frac{T_s - T_x}{T_s}\right) \quad (3)$$

Equation 2, 3 shows the Δh is plume rise, F is buoyancy (m4/s3), μ is the speed of the wind on an average day, a is the distancing yourself from the source, g is the gravity consistent, W is volumetric flow, $*(r_{-1}/u_{-x})$ for the environment pollution system, T_s at the place of emission of the pollutant, the temperature in the atmosphere is denoted as T_x, $\sqrt[2]{a^2 - p^2}$ in the virtual reality for the environment.

Equation 4 shows the decision variables a_r and b_r. Help us determine if the sensor or sink should be put at a given location. Because the deployment costs of sensors and sinks differ, they write d_r^{sensor} and d_r^{sink} to indicate the sensor and sink deployment costs, respectively, at position r. Our optimization models are geared toward reducing the overall deployment cost of sensors and sinks. As a result, the goal is to minimize the following objective function as seen in figure 5.

Equation 6 shows pollution dispersion models, creating a coverage limitation for the study. Our emission rate is equal to P Pollutants can be released if there is just one source of pollution. An atmospheric dispersion model identifies the pollution zone Z_i that will be affected if a pollution source

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I begins producing these pollutants, $\sqrt[2]{Z}$ through augmented reality in the smart cities, $\frac{1}{\delta^2}$ in Interactive Devices in Hypertext Systems.

$$Z_i = \{r \in R \text{ where } E_{ir} \geq E_0\} \tag{6}$$

Equation 7 shows the pollutant concentration is termed polluted when it surpasses a certain concentration threshold E_0 at a particular place in the environment, such as at point p when pollution from a source I first begin to be seen. Pollution sensors are assumed to be installed in sinks. The binary parameterW_{ir}, set to 1 if p is a member of Zi, is then defined. Otherwise, Wip is set to zero. $W_{ir}$is determined using the Gaussian dispersion model as follows.:

$$W_{ir} = \frac{P}{2\pi\mu\sigma_b\sigma_c} \frac{e^{-b^2}}{2\sigma_b} (\frac{e(-(c-H)^2)}{2\sigma_b} + \frac{e(-(c+H)^2)}{2\sigma_b}) \geq E_0 \tag{7}$$

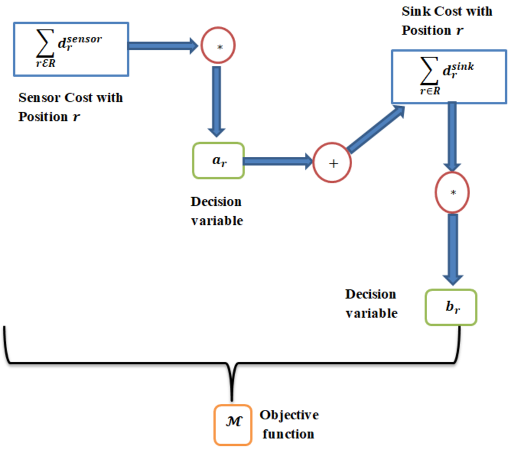

Figure 6: Objective function for the proposed approach.

$$\mathcal{M} = \sum_{r\varepsilon R} d_r^{sensor} * a_r + \sum_{r\in R} d_r^{sink} * b_r \tag{4}$$

Equation 5 states that a potential position r cannot be a sensor or a sink simultaneously.

$$a_r + b_r \leq 1, r \in R - \sqrt[2]{\mathbf{Z}} + \frac{\mathbf{1}}{\boldsymbol{\delta}^2} \tag{5}$$

In this case, b, c, P, μ, and H correspond to the same variables. A K Coverage constraint is derived using the Integer programming approach of the Set Covering P problem:

$$\sum_{r\in R} W_{ir} * (b_r + c_r) \geq K, i \in I \tag{8}$$

This approach, which assumes the coverage criteria remain the same, requires that all polluting sources be monitored by at least K sensors, as shown in Equation 8. Ki is the index appended to K to signify differential protection where the protection needs of the resources can vary.

$$\sum_{q\varepsilon 7_{(r)}} g_{rq} - \sum_{q\varepsilon 7_{(r)}} g_{rq} \geq K, i \in I \tag{9}$$

$$\sum_{q\varepsilon 7_{(r)}} g_{rq} - \sum_{q\varepsilon 7_{(r)}} g_{rq} \leq a_r, r \in R \tag{10}$$

Equation 9, 10 shows the flow idea is used to model connectedness. On the other hand, our formulation is superior in that it takes into account the same set of potential sensor and sink positions. Rand does not assume that the potential sensor and sink positions differ. The neighbor's set of nodes

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at potential location $\daleth_{(r)}$ is first denoted by the prefix $(r \in R)$. For this set, path loss models are the most appropriate. Node r communicates flow quantity to node q, utilised to define the decision variables g_{rq} are based on this information. A wireless sensor network has been set up to ensure that each sensor and sink is in contact with the others. Equations 9 and 10 verify that each sensor in the network produces a flow unit assuming an $r = 1$. Finally, environmental sustainability ratio, environmental monitoring ratio, co2 emission level, productivity ratio, temperature rate, precision ratio and utilization ratio were all considered. According to this study, artificial intelligence-based economic growth and financial factors have resulted (AI-EGF) compares survey findings with other studies.

4 RESULTS AND DISCUSSIONS

There are numerous smart city monitoring applications, including traffic analysis, pipeline network monitoring, protection detection and lamp monitoring, where nodes are deployed and sensors are managed. A major symptom of wireless signal propagation's vulnerability to external interference is the ease with which it can be disrupted and its integrity lost during transmission in complicated field environments. Ensure that the gateway node and network node are connected to a PC; set up serial data settings in the monitoring program. Connect to a serial port; Begin keeping track of applications; turn on a network node's power switch. Next, use the monitoring software to verify the corresponding values and real-time graphics. Performance metrics such as the data rate are critical due to environmental noise. With the ever-increasing demand for water monitoring, the autonomous surface vehicle system is constantly expanding its coverage area to take in big bodies of water like lakes and rivers. For the study's expansion, heavy metals ion and lithium-ion batteries are being studied as criteria of interest.

Parameters	*BCAI-ITS*	*MEC-ADMM*	*SCTS-CCPD*	*HSCCA*	*EDMS-WSN*
Environmental sustainability ratio (%)	45.7	55.67	65.6	47.7	92.11
Environmental monitoring ratio (%)	55.6	50.5	65.4	67.8	89.9
Co2 emission level (%)	62.3	52.3	42.3	64.3	93.8
Productivity ratio (%)	69.5	53.5	56.5	55.5	92.11
Temperature rate (%)	58.2	68.2	38.2	59.2	93.32
Precision ratio (%)	58.5	38.5	68.5	57.5	92.11
Utilization ratio (%)	58.5	38.5	68.5	57.5	96.8

Table 1: Comparisons of performance metrics.

Table 1 displays the business's ability to compare performance metrics. The overall aims are better supported if the metrics used to compute it falls within a predetermined range. They employ analytics to determine whether or not a method meets the needs of its users. When it comes to transforming

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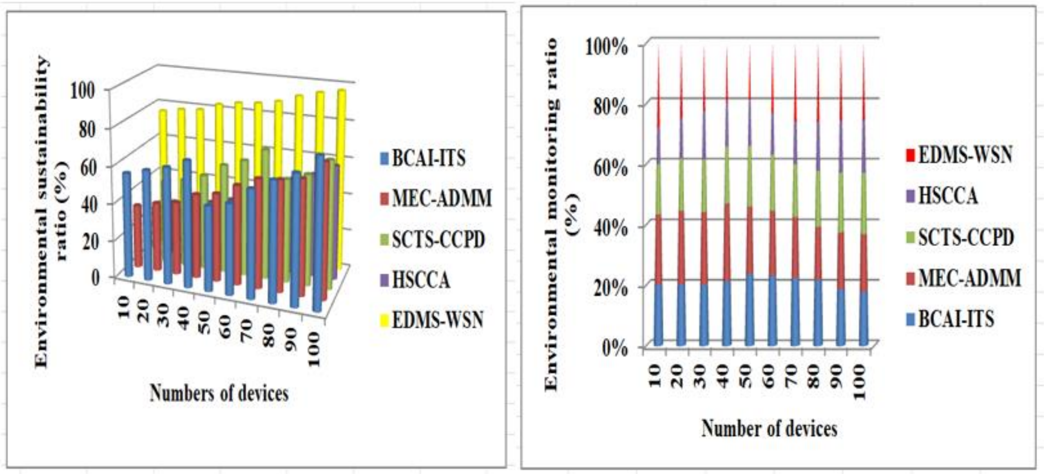
client needs and operational successes into comparable data, metrics are essential. If want to make an informed decision, must comprehend both measures and what they signify. Customers and operational demands can be translated into data through metrics, which are essential since they compare the two data sets' environments.

4.1 Environmental Sustainability Ratio (%) and Environmental Monitoring Ratio (%)

Figure 7(a) shows the Environmental sustainability ratio (%). The concept of environmental sustainability refers to meeting our current demands without compromising the rights and abilities of future generations to do the same. Soil, water, air, and energy pollution are avoided by reducing waste output and utilizing less harmful materials by conserving and reusing resources. Pollution of the environment and its consequences for human health are critical issues for a healthy environment. This delicate balance between our desire to advance economically and technologically safeguarding the surroundings in which they all live is at the heart of sustainability and sustainable development. There are several aspects to sustainability, including ensuring that no one or any area of life is negatively impacted by environmental legislation.



(a) (b)

Figure 7: (a) Environmental sustainability ratio (%) and (b) Environmental monitoring ratio (%).

It was about assessing the long-term repercussions of humanity's activities and asking questions about improving them. Over time, the term "sustainability" has broadened to encompass nearly every aspect of life on Earth, from the local to the global. Wetlands and forests with long lifespans and good health are good examples of long-term biological systems. Water, oxygen, nitrogen, and carbon are constantly re-distributed across the world's living and non-living systems by invisible chemical cycles. These cycles have been in operation since the dawn of time. It has become increasingly difficult for humans and other living systems to maintain a healthy balance of natural processes as human populations have grown. Figure 6(a)(b) shows the Environmental monitoring ratio (%). To assist policymakers at the national and international levels and the general public in understanding environmental challenges, environmental conditions and trends must be tracked. Surveillance has been ongoing in a few countries for the past decade. Many cities in the subregion have inadequate systems to keep tabs on dangerous urban air pollution levels. The effectiveness of policy instruments such as emissions levies and fines is diminished because of insufficient monitoring of solid and hazardous waste and industrial emissions. It was necessary to improve the monitoring of cross-border air pollution.

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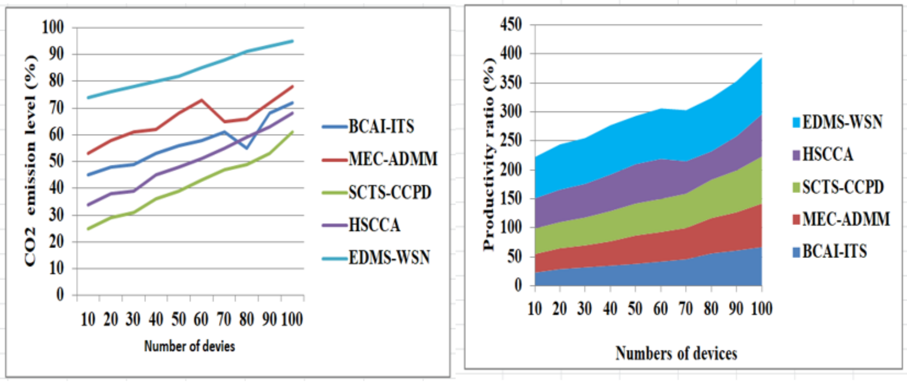
4.2 Co2 Emission Level (%) and Productivity Ratio (%)

Figure 8(a) shows the Co2 emission level (%). Carbon dioxide (CO2) emissions from fossil fuels in energy production and the extraction and exploitation of natural resources have become an international problem because of their impact on climate change. Environmental pollution has become a worldwide concern. Carbon dioxide is a benign gas in and of itself, as it is a necessary constituent of all living things. There are both benefits and drawbacks to the impact of CO2 on the ecosystem. Deforestation and the burning of fossil fuels have been the primary causes of the dramatic rise in atmospheric CO2 concentrations since the Industrial Revolution. Knowing how CO2 emissions affect air quality and the environment is needed.



(a) (b)

Figure 8: (a) Co2 emission level (%) and (b) Productivity ratio (%).

According to scientific explanations, carbon dioxide in the greenhouse effect contributes to air pollution. They must disperse all of the Earth's surface heat and radiation. – Physicist, although carbon dioxide levels are so high, there is an influence on ground-level ozone. Earth's surface traps heat, preventing it from cooling at night, and the oceans and the water remain warmer. Figure 7(b) shows the Productivity ratio (%). Data for the entire country is inaccurate because of the variances. For this reason, it is necessary to take measurements of each particular location. Each area is evaluated against the frontier line as a starting point for establishing a goal for enhancement. Therefore, it was necessary to conduct comparisons across different regions. Inefficiency assessments that consider various inputs and outcomes are a good measure of social welfare. Several evaluation targets were assessed using comparative productive inefficiency analysis. It is possible to see shifts in productive inefficiency throughout time. It was possible to show both the overall inefficiency of production and the various inputs and outputs separately. Because of the comparative nature of aggregate productive inefficiency assessments, they show an area is doing relative. The specific welfare goals of increasing economic growth and reducing pollution and disease-causing environmental factors are highlighted the individual inefficiencies in inputs and outputs that result from this system.

4.2.1 Temperature rate (%)

Figure 9 Estimating the qualities of volatile compounds (VOCs) emitted by construction products has been widely accepted. A new link between methanol emission and temperature has been derived using a theoretical method rather than the standard experimental one. To be sure the correlation

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works, the results of an experiment must match the correlation's predictions. Using the correlations established, it was possible to immediately determine the emission rate at degrees other than those used in the test.

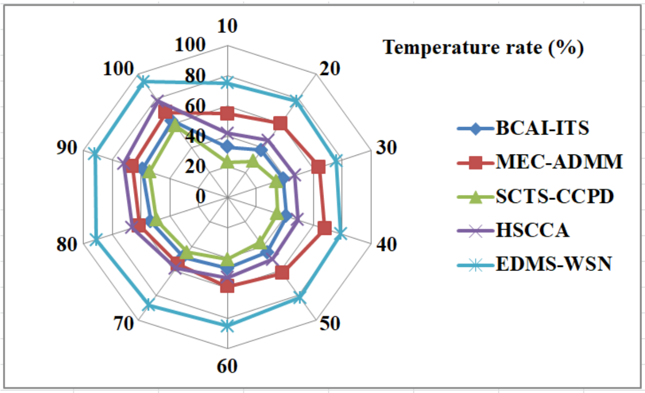

Figure 9: Temperature rate (%).

Further research on temperature emission rate correlation for formaldehyde was established in various settings, including the standard emission reference and moderately organic compounds. The molecular dynamics theory is introduced to offer a framework for this occurrence. With this new correlative relationship, they can now better predict the chemical emission characteristics of temperature-sensitive materials.

Number of devices	*Precision ratio (%)*				
	BCAI-ITS	*MEC-ADMM*	*SCTS-CCPD*	*HSCCA*	*EDMS-WSN*
10	31.36	65.37	77.52	91.22	92.11
20	30.01	66.65	77.27	92.11	92.15
30	39.94	64.57	77.94	87.62	93.18
40	38.24	64.22	78.51	88.71	94.24
50	38.82	66.42	78.79	89.15	94.48
60	47.52	72.12	79.34	69.31	95.27
70	47.27	74.54	80.45	70.72	96.9
80	45.94	63.04	81.65	50.64	97.32
90	55.57	66.14	82.87	41.72	95.76
100	55.128	64.12	83.11	42.92	92.11

Table 2: Precision ratio (%).

Table 2 shows the Precision ratio (%). Government authorities and industrialized sources need to know how much air pollution is in the air they breathe now. A pollutant's concentration is estimated using air dispersion models. Air dispersion in this study will develop a more efficient way to evaluate air dispersion models. As part of their performance evaluation, RMSE and Brier scores were used to quantify changes in accuracy and precision, respectively. Results show that if the environmental

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performance indicator is accurately declared but lacks precision, a negligence rule results in lower actual pollution levels than strict liability. As long as managers are allowed to manipulate the environmental performance metric that is publicly posted, pollution levels will rise. Under a negligence system, manipulation helps shareholders avoid guilt, but under a strict liability regime, manipulation hurts shareholders because of more pollution and higher estimated compensation payments. Because of this, the level of manipulation is higher in a regime of negligence. According to research, the liability regime influences environmental reporting and real pollution decisions, contributing to the environmental performance literature.

Number of devices	*Utilization cost (%)*				
	BCAI-ITS	*MEC-ADMM*	*SCTS-CCPD*	*HSCCA*	*EDMS-WSN*
10	41.8	65.9	77.8	84.2	90.6
20	42.4	66.7	77.7	84.3	91.7
30	49.0	64.6	77.4	85.6	92.3
40	48.0	64.9	78.5	86.9	93.3
50	46.8	66.3	78.7	86.5	93.7
60	47.8	72.2	79.2	87.4	94.6
70	47.7	74.2	80.3	88.6	95.7
80	45.5	63.0	81.6	89.2	95.9
90	55.5	66.1	82.8	90.5	96.3
100	55.1	64.1	83.1	90.9	96.8

Table 3: Utilization cost (%).

Table 3 shows the utilization cost (%). Most COI expenses are direct, indirect, and intangible charges. In addition to direct health care costs (such as caregivers' time, crop and forest damage, material damage, and visibility costs), indirect non-healthcare costs (such as caregiver time, crop and forest damage, material damage, and visibility costs; informal care is an important component of indirect non-healthcare costs) are worth noting. Expenses incurred due to decreased productivity are often referred to as "indirect costs." Expenses related to illness and deaths are included in this category. Pain and suffering and the limitations they place on a patient's quality of life are reflected in the intangible costs of treatment. Top-down or bottom-up designs are possible for studies based on researchers' data at their disposal. In top-down research, data from databases and registers are utilized to estimate the expenses for a large population sample. In contrast, bottom-up studies focus on individual patients and extrapolate those costs to the whole. Because not all expenditures associated with a particular sickness or condition can be found in registers, the first method has limitations. At the same time, the second relies on a representative sample of patients. An experimental examination on EDMS-WSN demonstrates that the proposed approach is highly competitive in predicting high accuracy compared to existing systems.

Figure 10 says human-computer interaction is a hallmark of interactive systems, defined by a high degree of human-computer interaction. Since they were children, most computer users have been exposed to the graphical user interfaces (GUIs) of Macintosh and Windows. The whole of all living and non-living things and their consequences on human existence is what is meant by the environment. Animals, plants, forests, and fisheries are all biotic elements, whereas water, land, sunshine, rocks, and air are abiotic elements.

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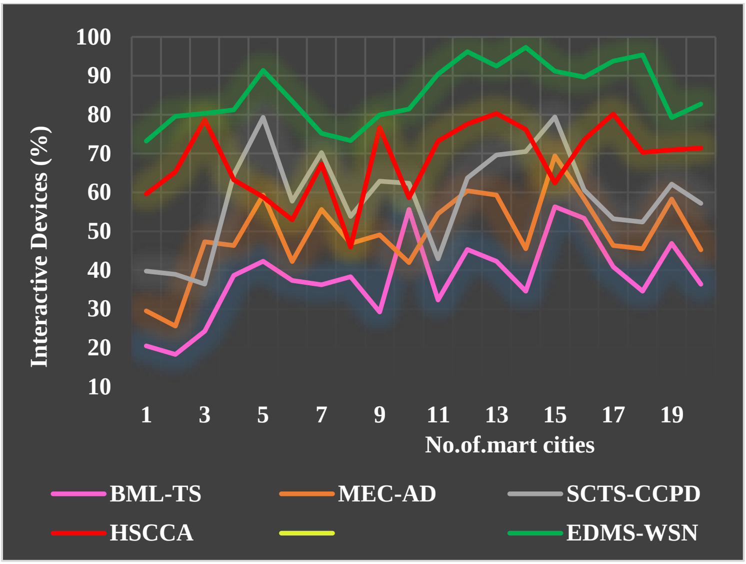

Figure 10: Development of interactive devices in hypertext systems in environment.

The environment is all of the external physical, chemical, and biological variables and behaviors. Non-environmental behaviors, as well as those that are tied to social and cultural contexts, are not included in this description.

5 CONCLUSIONS

The current state of the environment and the difficulties that exist are discussed in this paper, the necessity of implementing a system for environmental monitoring. Hypertext for education was examined in light of these tendencies and their ramifications. Researchers and hypertext database builders alike received a wealth of information and ideas for future study. Participants were shown how to minimize their plastic use using a virtual reality experience, which made more environmentally friendly decisions in the real world. Area network sensor networks are used to monitor pollutants in the environment. The most critical aspects of this paper are: A wireless sensor network-based air pollution monitoring system has been developed. The system's needs and general design are analyzed and recorded at the project's outset. Over a wireless network, data from the environmental information acquisition terminal is sent. An algorithm was used to improve wireless sensor network quality measurements. Despite the system's monitoring of the atmosphere in real-time, there is still a need for improvements before it is produced. Future data collecting terminals will have greater hardware, server, and client stability. The numerical results show that the suggested method has an environmental sustainability ratio of 92.11%, environmental monitoring ratio of 89.9%, a CO2 emission level of 93.8%, a temperature rate of 93.32%, a utilization cost of 96.8%, and a precision ratio of 92.11%, and productivity ratio of 92.11%, overall performance in interactive device 93.88% than other existing methods.

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REFERENCES

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[1] Arroyo, P.; Herrero, J.-L.; Suárez, J.-I.; Lozano, J.: Wireless Sensor Network Combined with Cloud Computing for Air Quality Monitoring, Sensors, 19(3), 2019, 691. https://doi.org/10.3390/s19030691

[2] Azri, S.; Ujang, U.; Rahman, A.-A.: 3D Geo-Clustering for a Wireless Sensor Network in a Smart City, International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 2019, 42(4/W12). https://doi.org/10.5194/isprs-archives-XLII-4-W12-11-2019

[3] Banerjee, A.; De, S.-K.; Majumder, K.; Das, V.; Giri, D.; Shaw, R.-N.; Ghosh, A.: Construction of Effective Wireless Sensor Network for Smart Communication Using Modified Ant Colony Optimization Technique, In Advanced Computing and Intelligent Technologies Springer, Singapore, 2022, 269-278. https://doi.org/10.1007/978-981-16-2164-2_22

[4] Carratù, M.; Ferro, M.; Pietro Santo, A.; Sommella, P.; Paciello, V.: A Smart Wireless Sensor Network for PM10 Measurement, In 2019 IEEE International Symposium on Measurements & Networking (M&N) IEEE, 2019, 1-6. https://doi.org/10.1109/IWMN.2019.8805015

[5] Chu, Z.; Cheng, M.; Yu, N.-N.: A Smart City is a Less Polluted City, Technological Forecasting and Social Change, 172, 2021, 121037. https://doi.org/10.1016/j.techfore.2021.121037

[6] Deveci, M.; Pekaslan, D.; Canıtez, F.: The Assessment of Smart City Projects Using Zslice Type-2 Fuzzy Sets Based Interval Agreement Method, Sustainable Cities and Society, 53, 2020, 101889. https://doi.org/10.1016/j.scs.2019.101889

[7] Di, Leo G.; Ferro, M.; Liguori, C.; Pietro Santo, A.; Paciello, V.: Wireless Sensor Network in Smart City Pilots: The Case of Salerno in Italy (from 2015 to 2019), Smart Cities and Smart Governance: Towards the 22nd Century Sustainable City, 2021, 303-322. https://doi.org/10.1007/978-3-030-61033-3_14

[8] Fuertes, W.; Cadena, A.; Torres, J.; Benítez, D.; Tapia, F.; Toulkeridis, T.: Data Analytics on Real-Time Air Pollution Monitoring System Derived from a Wireless Sensor Network, In International Conference on Information Technology & Systems Springer, Cham, 2019, 57-67. https://doi.org/10.1007/978-3-030-11890-7_6

[9] Fan, X.; et.al.: Importance of Combination of Ecology and Literature, Transactions on Asian and Low- Resource Language Information Processing, 2022. https://doi.org/10.1145/3519597

[10] Grace, R.-K.; Manju, S.: A Comprehensive Review of Wireless Sensor Networks Based Air Pollution Monitoring Systems, Wireless Personal Communications, 108(4), 2019, 2499-2515. https://doi.org/10.1007/s11277-019-06535-3

[11] Han, Q.; Liu, P.; Zhang, H.; Cai, Z.: A Wireless Sensor Network for Monitoring Environmental Quality in the Manufacturing Industry, IEEE Access, 7, 2019, 78108-78119. https://doi.org/10.1109/ACCESS.2019.2920838

[12] Jalali, R.; El-Khatib, K.; McGregor, C.: Smart City Architecture for Community Level Services Through the Internet of Things, In 2015 18th International Conference on Intelligence in Next Generation Networks, IEEE, 2015, 108-113. https://doi.org/10.1109/ICIN.2015.7073815

[13] Jamil, M.-S.; Jamil, M.-A.; Mazhar, A.; Ikram, A.; Ahmed, A.; Munawar, U.: Smart Environment Monitoring System by Employing Wireless Sensor Networks on Vehicles for Pollution Free Smart Cities, Procedia Engineering, 107, 2015, 480-484. https://doi.org/10.1016/j.proeng.2015.06.106

[14] Jia, A.; Xu, C.: Smart City Image Landscape Design Based on Wireless Sensors, Microprocessors and Microsystems, 83, 2019, 104022. https://doi.org/10.1016/j.micpro.2021.104022

[15] Jiang, D.: The Construction of Smart City Information System Based on the Internet of Things and Cloud Computing, Computer Communications, 150, 2020, 158-166. https://doi.org/10.1016/j.comcom.2019.10.035

[16] Jiang, J.; Wang, H.; Mu, X.; Guan, S.: Logistics Industry Monitoring System Based on Wireless Sensor Network Platform, Computer Communications, 155, 2020, 58-65. https://doi.org/10.1016/j.comcom.2020.03.016

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[17] Jin, J.; Gubbi, J.; Marusic, S.; Palaniswami, M.: An Information Framework for Creating a Smart City Through Internet of Things, IEEE Internet of Things Journal, 1(2), 2014, 112-121. https://doi.org/10.1109/JIOT.2013.2296516

[18] Jing, C.; Shu, D.; Gu, D.: Design of Streetlight Monitoring and Control System Based on Wireless Sensor Networks, In 2007 2nd IEEE Conference on Industrial Electronics and Applications, IEEE, 2007, 57-62. https://doi.org/10.1109/ICIEA.2007.4318369

[19] Kafi, M.-A.; Challal, Y.; Djenouri, D.; Doudou, M.; Bouabdallah, A.; Badache, N.: A Study of Wireless Sensor Networks for Urban Traffic Monitoring: Applications and Architectures, Procedia Computer Science, 19, 2013, 617-626. https://doi.org/10.1016/j.procs.2013.06.082

[20] Leccese, F.; Cagnetti, M.; Trinca, D.: A Smart City Application: A Fully Controlled Street Lighting Isle Based on Raspberry-Pi Card, a ZigBee Sensor Network and WiMAX, Sensors, 14(12), 2014, 24408-24424. https://doi.org/10.3390/s141224408

[21] Li, L.; Xiaoguang, H.; Ke, C.; Ketai, H.: The Applications of Wifi-Based Wireless Sensor Network in Internet of Things and Smart Grid, In 2011 6th IEEE Conference on Industrial Electronics and Applications, IEEE, 2011, 789-793. https://doi.org/10.1109/ICIEA.2011.5975693

[22] Lv, Z.; Chen, D.; Lou, R.; Wang, Q.: Intelligent Edge Computing Based on Machine Learning for Smart City, Future Generation Computer Systems, 115, 2021, 90-99. https://doi.org/10.1016/j.future.2020.08.037

[23] Malche, T.; Maheshwary, P.; Kumar, R.: The Smart City's Environmental Monitoring System is Based on Secure Internet of Things (IoT) Architecture, Wireless Personal Communications, 107(4), 2019, 2143-2172. https://doi.org/10.1186/s40537-019-0268-2

[24] Munir, S.-A.; Ren, B.; Jiao, W.; Wang, B.; Xie, D.; Ma, J.: Mobile Wireless Sensor Network: Architecture and Enabling Technologies for Ubiquitous Computing, In 21st International Conference on Advanced Information Networking and Applications Workshops (AINAW'07) IEEE, 2, 2007, 113-120. https://doi.org/10.1109/AINAW.2007.257

[25] Postolache, O.; Pereira, J.-D.; Girão, P.-S.: Wireless Sensor Network-Based Solution for Environmental Monitoring: Water Quality Assessment Case Study, IET Science, Measurement & Technology, 8(6), 2014, 610-616. https://doi.org/10.1049/iet-smt.2013.0136

[26] Raipure, S.; Mehetre, D.: Wireless Sensor Network Based Pollution Monitoring System in Metropolitan Cities, In 2015 International Conference on Communications and Signal Processing (ICCSP), IEEE, 2015, 1835-1838. https://doi.org/10.1109/ICCSP.2015.7322841

[27] Sendra, S.; Garcia-Navas, J.-L.; Romero-Diaz, P.; Lloret, J.: Collaborative Lora-Based Sensor Network for Pollution Monitoring in Smart Cities, In 2019 Fourth International Conference on Fog and Mobile Edge Computing (FMEC) IEEE, 2019, 318-323. https://doi.org/10.1109/FMEC.2019.8795321

[28] Sengan, S.; Subramaniyaswamy, V.; Nair, S.-K.; Indragandhi, V.; Manikandan, J.; Ravi, L.: Enhancing Cyber–Physical Systems with Hybrid Smart City Cyber Security Architecture for Secure Public Data-Smart Network, Future generation computer systems, 112, 2020, 724-737. https://doiorg/10.1016/j.future.2020.06.028

[29] Singh, S.; Sharma, P.-K.; Yoon, B.; Shojafar, M.; Cho, G.-H.; Ra, I.-H.: Convergence of Blockchain and Artificial Intelligence in IoT Network for the Sustainable Smart City, Sustainable Cities and Society, 63, 2020, 102364. https://doi.org/10.1016/j.scs.2020.102364

[30] Siregar, B.; Nasution, A.-B.-A.; Fahmi, F.: Integrated Pollution Monitoring System for a Smart City, In 2016 International Conference on ICT for Smart Society (ICISS), IEEE, 2016, 49-52. https://doi.org/10.1109/ICTSS.2016.7792847

[31] Staletić, N.; Labus, A.; Bogdanović, Z.; Despotović-Zrakić, M.; Radenković, B.: Citizens' Readiness to Crowdsource Smart City Services: A Developing Country Perspective, Cities, 107, 2020, 102883. https://doi.org/10.1016/j.cities.2020.102883

[32] Wang, C.; Li, S.; Cheng, T.; Li, B.: A Construction of Smart City Evaluation System Based on Cloud Computing Platform, Evolutionary Intelligence, 13(1), 2020, 119-129. https://doi.org/10.1007/s12065-019-00259-w

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[33] Wang, H.: Sustainable Data Analysis Framework of Smart City Based on Wireless Sensor Network, International Journal of Networking and Virtual Organisations, 25(2), 2021, 114-133. https://www.inderscienceonline.com/doi/abs/10.1504/IJNVO.2021.119059

[34] Yi, W.-Y.; Lo, K.-M.; Mak, T.; Leung, K.-S.; Leung, Y.; Meng, M.-L.: A Survey of Wireless Sensor Network Based Air Pollution Monitoring Systems, Sensors, 15(12), 2015, 31392-31427. https://doi.org/10.3390/s151229859

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